Region One Vegetation Classification, Mapping, Inventory and Analysis Report

$$\bar{x} = \frac{\sum x}{n}$$

Overview of FIA and Intensified Grid Data

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Overview of FIA

Forest Inventory and Analysis:

The national Forest Inventory and Analysis (FIA) program provides a congressionally mandated, statistically-based, continuous inventory of the forest resources of the United States. The FIA inventory design is based on a spatially-balanced sample of inventory plots. Data about trees, and associated characteristics are collected on all

forested[1] portions of the plots, throughout the United States, regardless of ownership. The FIA sampling frame uniformly covers all forested lands, regardless of management emphasis. Therefore, wilderness areas, roadless areas, and actively managed lands all have the same probability of being sampled. Data collection standards are strictly controlled by FIA protocols. The sample design and data collection methods are scientifically designed, publicly disclosed, and repeatable. Data collection protocols are available on the internet (http://www.fia.fs.fed.us/). There are also stringent quality control standards and procedures, carried out by FIA personnel of the Rocky Mountain Research Station, which oversee the FIA data collection for Region 1 (R1). All of this is designed to assure that data is collected consistently throughout the United States, and that stated accuracy standards are met by field crews.

To conduct analysis of forest attributes over large areas, it is infeasible to maintain an inventory of all vegetation on every acre, for the millions of acres of land within the Region.   FIA provides a statistically-sound representative sample designed to provide unbiased estimates of forest conditions at broad- and mid-levels. A statistical sample provides the means to observe a randomly selected subset of the entire population and make inferences about the entire population. Since variability exists across a landscape, statistical sampling provides metrics to determine how accurately the estimates apply to the entire population. Statistical sampling provides methods for estimating population characteristics and evaluating the reliability of the estimates. The variability of the attribute of interest, number of plots analyzed, and the size of the plots affect the reliability of the estimate.

This inventory design is appropriate for making estimates of a variety of attributes of forested lands across large landscapes such as National Forests, multiple fifth-code watersheds, and ecological section. The FIA sampling frame uniformly covers all lands, regardless of management emphasis. Therefore, wilderness areas, roadless areas, and actively managed lands all have the same probability of being sampled.   More detail on the statistical foundation of using FIA data on National Forests is found in: *Application of Forest Inventory and Analysis (FIA) Data to Estimate the Amount of Old Growth Forest and Snag Density in the Northern Region of the National Forest System.*

Furthermore, the plots are monumented and the trees are tagged. This allows for accurate remeasurement of the plots over time. Currently, the plots in Region 1 are remeasured on a 10-year cycle. This allows for monitoring trend in vegetation over time.

Sample Design used for FIA data:

FIA plot design and layout has changed over the years. Comprehensive manuals used for data collection from 1998 to present are available from the IW-FIA website. From 1992-1998, an FIA plot consisted of a cluster of 5-7 subplots. The number of subplots installed depended upon the year of inventory; early inventories had a seven-point cluster, whereas later inventories had 5 points. Trees 5.0" diameter breast height (DBH) and larger were selected with a basal-area factor of 40. Furthermore, if major differences in forest type or size-class were observed from one subplot to the next, the subplots were "rotated" into the same condition as subplot 1. For example if subplot 1 was sawtimber and subplot 2 was a clearcut, subplot 2 was rotated into a sawtimber condition following specific protocols. This design was used from 1992 – 1998 for Forests whose majority of the lands they administer were in the state of Montana. This design is sometimes referred to as the rotated design.

After 1996, FIA adopted a national plot layout consisting of 4 fixed-radius (1/24th acre) subplots. Under this current design, subplots are no longer rotated, instead general forest conditions, based on structure, type, and

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[1] "..land at least 10 percent stocked, or currently nonstocked but formerly having such stocking, with timber and/or woodland trees, and where human activity on the site does not preclude natural succession of the forest (i.e., the site will be naturally or artificially regenerated)." *Interior West Forest Land Resource Inventory Field Procedures, 1995-1996.*

ownership are "mapped" on each subplot. In 2002, Region 1 worked with IW-FIA to modify the national layout by adding a ¼-acre macro-plot. These protocols were integrated into the IW field procedures and data collection software, and loaded into IW-FIA's database. These protocols dictated that trees 5.0 – 20.9 inches DBH were measured on the 1/24th- acre subplot and trees 21.0 inches DBH and larger were measured on a ¼-acre subplot. Data collected in 2002 was completed by IW-FIA crews while installing the mapped plot. All plots that did not have the ¼-acre plot installed in 2002, had the ¼-acre subplot augmented from the standard FIA plot layout in 2003 and 2004. These data were measured by contract crews, overseen by Region 1, using IW protocols and software. For a detailed description of field procedures see http://fsweb.ogden.rmrs.fs.fed.us/data_collection/data_collection.html. This "large-tree macro plot" design was used for the Idaho plots installed from 1998 to 2002.

Table 1. Date and type of FIA *Periodic* Inventory by National Forest

National Forest	Date of Inventory	Type of Design	Total # of Plots	Number of rotated plots
Eastern Montana				
Beaverhead-Deerlodge	1996-1997	5 subplots, rotated	547	27
Custer	1997	5 subplots, rotated	195	11
Gallatin	1997-1998	5 subplots, rotated	285	13
Helena	1996-1998	5 subplots, rotated	149	8
Lewis & Clark	1996-1997	5 subplots, rotated	299	16
Western Montana				
Bitterroot	1994-1995	5 subplots, rotated	252	7
Flathead	1993-1994	5-7 subplots, rotated	382	20
Kootenai	1993-1997	5-7 subplots, rotated	370	19
Lolo	1995-1996	5 subplots, rotated	347	22
Northern Idaho				
Idaho Panhandle	2000-2003	4 subplots, mapped	413	NA
Clearwater	1998-2002	4 subplots, mapped	305	NA
Nez Perce	2000-2002	4 subplots, mapped	339	NA

Until 2003, the FIA inventory was implemented in a periodic manner, all of the plots on any given Forest, were measured within a 1-2 year time frame (see Table 1).

In 2003, the annual inventory began in Montana and the following year in Idaho. The current annual FIA procedures use the mapped-plot design, with a 1/24th acre large-tree plot, where 10% are measured, in a spatially balanced manner, across all Forests every year. Therefore, all Forests have plots measured yearly with all plots on a Forest measured in a 10-year time frame. Currently plots measured through 2011 are available to the Region.

Down-Woody Material

Down-woody material (DWM) has not been collected in a consistent manner on the FIA plots over time. The rotated design plots, installed in Montana in the 1990's, had DWM collected on subplot 1. When this data was loaded into FSVeg, the DWM values for subplot 1 were duplicated for all of the other subplots on the plot. This still provides consistent DWM estimates for the plot.

DWM was not collected on the mapped plots until 2005. At that time, there was no national standard DWM core optional protocols and IW-FIA was piloting DWM protocols only in the state of Montana. These protocols collected Brown's Transect information on subplots 2, 3, and 4. These protocols were used throughout R1 starting in 2006 and remained in use through 2012. Starting in 2013, a national FIA core-optional DWM protocols were adopted.

All Condition Inventory:

Starting with the FIA annual plots collected in 2004, the Region has been contracting with IW-FIA to collect the "All Condition Inventory" (ACI). This inventory supplements the base FIA plots by measuring "FIA protocols" on those plots and portions thereof that do not meet FIA's definition of "forested". In 2008, the ACI was extended from Montana and Idaho, those lands under Interior West FIA jurisdiction, into North Dakota and South Dakota, states under Northern FIA jurisdiction. In 2009, the RIM board decided not to fund the inventory in North Dakota and South Dakota. 20% of the plots in ND and SD were measured in 08. In 2010 the RIM board funded the inventory in ND and SD; however they decided to fund only 10% of the plots. Currently, IW-FIA is collecting ACI as part of their standard field data collection throughout the Region.

FIA Analysis Dataset:

An "FIA Analysis Dataset" is a set of FIA plots that is available for analysis using R1 analysis tools such as the R1 Summary Database. An Analysis Dataset contains one inventory plot for each location across the Region. Since FIA data has been remeasured over time, an analysis dataset is the most recent available measurement. The first Analysis Dataset used in this Region was comprised solely of the periodic data. A "hybrid" FIA Analysis Dataset is created each time a new set of FIA inventory data are brought into FSVeg and made available for analysis. This dataset contains the most recent available data for each inventory point location across the Region. Therefore, a Hybrid FIA Dataset contains:

- all of the annual plots that are available in FSVeg for R1 Forests
- any periodic plots where annual plots have not been measured/released to NFS

Currently, the Hybrid FIA 2011 Analysis Dataset is the most complete set of FIA data available in the R1 Summary Database suite of analysis tools, see *R1 Summary Database Reports and Utilities*. For documentation on how an Analysis Dataset is created, see *Creating an Analysis Dataset to be used in the R1 Summary Database.*

At this time, there are five Analysis Datasets associated with FIA data and available in the R1 Summary Database: the R1 Periodic, see Table 1; the R1 Hybrid 2011, see Tables 2 and 3; the R1 Annual 2011, which are all annual plots measured through 2011, see Table 2; the R1 Hybrid 2007, see Tables 4 and 5; and the R1 Annual 2007, see Table 4.

Table 2: Total number of plots by National Forest and vintage of data for Hybrid 2011 FIA data. Measurement years with * notes that some plots were scheduled to be measured in 2011, but did not get measured until 2012.

Forest	# of Periodic plots	Measurement years of periodic inventory	# of Annual plots	Measurement years of annual inventory	Total # plots
02: Beaverhead-Deerlodge	42	1997	517	2003 - 2011*	559
03: Bitterroot	32	1994 - 1995	228	2003 - 2011	260
04: Idaho Pandhandle	98	2000 - 2003	325	2004 - 2011*	423
05: Clearwater	55	1998 - 2001	249	2004 - 2011*	304
08: Custer	22	1997	188	2003 - 2011*	210
10: Flathead	41	1993-1994	357	2003 - 2011*	398

Forest	# of Periodic plots	Measurement years of periodic inventory	# of Annual plots	Measurement years of annual inventory	Total # plots
11: Gallatin	32	1997 - 1998	279	2003 - 2011*	311
12: Helena	13	1996 - 1998	137	2003 - 2011	150
14: Kootenai	33	1993-1995	352	2003 - 2011	385
15: Lewis & Clark	30	1996	276	2003 - 2011	306
16: Lolo	33	1995-1996	319	2003 - 2011	352
17: Nez Perce	65	2000 - 2002	279	2004 - 2011	344

Table 3: Breakdown of plots by proportion of FIA conditions of forest/non-forest and sampled/non-sampled. This table provides information about how complete the Hybrid FIA 2011 Inventory Dataset is. Mixed means mixed conditions, predominately Forest Sampled and Non-forest Sampled or Forest Sampled and Non-forest Non-sampled. In general, non-forest non-sampled plots have not been measured under the annual design since the ACI started.

Forest	# Plots	Forest Sampled	Forest Non-sampled	Non-Forest Sampled	Non-Forest Non-Sampled	Water	Mixed	Total # Plots in Analysis Area
02: Beaverhead-Deerlodge	559	410	7	61	20	0	61	559
03: Bitterroot	260	220	6	5	6	0	23	260
04: Idaho Pandhandle	423	373	3	4	2	11	30	412
05: Clearwater	304	260	3	11	1	0	29	304
08: Custer	210	104	9	48	17	0	32	210
10: Flathead	398	334	6	5	4	4	45	394
11: Gallatin	311	224	6	30	10	2	39	309
12: Helena	150	138	0	6	1	0	5	150
14: Kootenai	385	334	4	4	5	4	34	381
15: Lewis & Clark	306	263	1	9	6	0	27	306
16: Lolo	352	310	2	5	4	0	31	352
17: Nez Perce	344	302	7	9	4	0	22	344
Total	4002							3981

Plots that land in water, are associated with the nearest Forest by FIA however, these plots are not considered within the administrative boundaries so are removed from the Analysis Dataset.

Table 4: Total number of plots by National Forest and vintage of data for Hybrid 2007 FIA data.

Forest	# of Periodic plots	Measurement years of periodic inventory	Number of Annual plots	Measurement years of annual inventory	Total # plots
02: Beaverhead-Deerlodge	252	1996 - 1997	290	2003 - 2007	542
03: Bitterroot	125	1994 - 1995	128	2003 - 2007	253
04: Idaho Panhandle	241	2000 - 2003	157	2004 - 2007	398
05: Clearwater	172	1998 - 2001	125	2004 - 2007	297
08: Custer	110	1997	90	2003 - 2007	200
10: Flathead	197	1993 - 1994	188	2003 - 2007	385
11: Gallatin	130	1997 - 1998	166	2003 - 2007	296
12: Helena	65	1996 - 1998	80	2003 - 2007	145
14: Kootenai	167	1993 - 1997	201	2003 - 2007	368
15: Lewis & Clark	147	1996 - 1997	152	2003 - 2007	299
16: Lolo	162	1995 - 1996	183	2003 - 2007	345
17: Nez Perce	198	2000 - 2002	143	2004 - 2008	341

Table 5: Breakdown of plots by proportion of FIA conditions of forest/non-forest and sampled/non- sampled. This table provides information about how complete the Hybrid FIA 2007 Inventory Dataset is. Mixed means mixed conditions, predominately Forest Sampled and Non-forest Sampled or Forest Sampled and Non-forest Non-sampled. In general, non-forest non-sampled plots have not been measured under the annual design since the ACI started.

Forest	# plots	Forest Sampled	Forest Non-sampled	Non- Forest Sampled	Non-Forest Non-Sampled	Water	Mixed
02:Beaverhead-Deerlodge	542	413	4	32	54	2	37
03: Bitterroot	253	219	5	1	16	1	11
04: Idaho Panhandle	398	361	3	2	2	0	30
05: Clearwater	297	256	0	6	4	0	31
08: Custer	200	107	3	19	56	0	15
10: Flathead	385	326	3	4	15	5	32
11: Gallatin	296	217	4	19	29	1	26
12: Helena	145	133	0	2	5	0	5
14: Kootenai	368	327	2	1	11	2	25
15: Lewis & Clark	299	262	0	7	16	1	13
16: Lolo	345	310	3	2	12	1	17
17: Nez Perce	341	291	10	7	7	0	26
Total	3869						

Mid-Cycle Remeasurement of FIA Plots

If Forests have had extensive fire and/or insects, they can choose to do a "mid-cycle" remeasurement of FIA plots. This is a targeted inventory remeasuring plots that appear to have been affected by disturbance, for example, within fire perimeter boundaries. These inventories do not remeasure all of the data that is collected by FIA, it focuses on collecting attributes that have probably been impacted by the disturbance, such as tree status, down-woody material, understory vegetation, and surface cover attributes. Data collection is overseen by the Region 1 Regional Office using NFS corporate tools. For information on the general protocols, see *Mid-cycle Remeasurement of FIA Plot Using IM Protocols.*

At this time, the Custer/Gallatin National Forest is the only Forest that has remeasured FIA plots due to fire. This mid-cycle remeasurement was focused on remeasuring any plot that had burned since measurement based on fires that burned from 2006 – 2012. Table 5 shows the number of plots burned by fire and fire year.

Table 5: Number of FIA plots burned on the Custer/Gallatin by fire and year.

Fire Name	Fire Year	Number FIA plots affected
Derby	2006	3
Jungle	2006	2
Watt	2006	3
Lost	2007	2
Wicked Creek	2007	2
Cascade	2008	1
Bull	2011	1
Maverick Fire	2011	1
Mill Creek Fire	2011	1
Ash Creek	2012	10
Dugan	2012	2
Dutch	2012	2
Millie Fire	2012	1
Pine Creek	2012	1
Taylor Creek	2012	7
Emigrant	2013	2
Total		41

A hybrid Analysis Dataset has been created for the Custer/Gallatin that includes the FIA Hybrid 2011 plots that have not burned and the mid-cycle remeasurement plots for those plots that have burned. This is called the F08 F11 MidCycle Hybrid 2015 Analysis Dataset.

Overview of R1 Intensified Grid

At the mid-level, inventory is conducted only on those lands where there is a need for vegetation information within specific geographic areas. The intensity of the intensified grid inventory is based on information needs and funding. Note: all lands mapped at a mid-level may not have a mid-level inventory nor need one. For larger geographic areas, Ranger Districts, etc. more general mid-level management questions can be answered using the base FIA grid data.

The most flexible approach to mid-level inventory supported in Region 1 is intensification of the FIA grid which allows maximum flexibility in analysis to meet multi-resource information needs. Furthermore, plot locations are monumented, allowing a Forest to re-measure the vegetation attributes to monitor changes over time. These efforts can be targeted to those plots affected by natural or person-caused events which alter the vegetation so that an updated existing condition can be assessed and changes due to an event can be determined.

The Region has developed tools for determining the number of plots needed to meet information needs (Berglund and Leach, 2006) and locating the plots (Zeiler and others, 2010). Field inventory protocols for intensification are similar to those used by IW-FIA for data collection. The data is collected using modified Common Stand Exam Inventory and Monitoring protocols to mimic the FIA protocols (*Region 1 Grid Intensification using Inventory and Monitoring Protocols*) however only a single 1/24 acre plot is installed. Down-woody material, vegetation composition, and surface cover collected are collected. Information is collected on all conditions.

Once data is collected, it is loaded into FSVeg and is ultimately loaded into the R1 Summary Database for analysis. For further information about planning for an intensified inventory, see *A Planning Guide for the R1 Intensified Grid Inventory and Associated Analysis.* An intensified grid inventory and the associated analysis builds on Forest Inventory and Analysis (FIA) data and associated analysis tools that have been developed by Region 1. The *R1 Multi-level Vegetation Classification, Mapping, Inventory, and Analysis System* (Berglund and others, 2009) explains the relationship of the Intensified Grid Inventory to the FIA data and the associated analysis.

Intensified Grid Analysis Datasets:

In general, Intensified Grid Analysis Datasets are comprised of the intensified grid plots and subplot 1 of the FIA Analysis Dataset that is currently being used.

Table 4. Intensified Grid Analysis datasets currently available through the R1 Summary Database Applications.

Forest	Analysis Dataset Name	# Plots	Years of data collection	Geographic area of inference	Brief Description
10 - Flathead	IntGrid Tally Lake 4X M1 (CN 1000007)	184 plots 40 FIA 144 IG	FIA:1993-94 IG 2006	Tally Lake area of the Flathead NF.	Measurement 1 of 4x intensification. Includes subplot 1 from Periodic FIA Analysis Dataset.
12 - Helena	F12 IntGrid 4X Hybrid 2010 (CN 1000011)	781 plots 145 FIA 636 IG	1996-2010 FIA: 1996-2007 IG: 2006-10	Administrative area of Helena NF	Most recent available data as of 2010, combination of all of the Helena Intensified Grid 4X intensification Mid-Cycle Remeasurement plots and the initial inventory plots that were not remeasured. Data set contains information from subplot 1 of FIA Hybrid 2007 plots falling within the geographic extent of the intensification.
15 – Lewis and Clark	F15 IntGrid Eastside 4X 2007 (CN 1000006) Note: the name of this analysis dataset is not consistent w/current naming conventions, should be 2010 not 2007	862 Plots 158 FIA 704 IG	1996-2010 FIA: 1996-2007 IG: 2009-10	Subset of the Lewis and Clark NF, see Figure 1.	Lewis and Clark Intensified Grid, 4X intensification, measurement 1. Data set contains information from plot 1 of FIA Hybrid 2007 plots falling within the geographic extent of the intensification that had been completed by 2010.
15 – Lewis and Clark	F15 IntGrid 4X M1 2013 (Inv. Dataset CN 1000026)	992 Plots 183 FIA plots 809 IG	1996-2013 FIA: 1996-2007 IG: 2009-10, 2012-13	Subset of the Forest, see Figure 2. This analysis dataset does not include the Big Snowies and the northern portion of the Front Range.	Lewis and Clark Intensified Grid, 4X intensification, measurement 1. This includes the most recent available 4x intensified grid data and subplot 1 of the Hybrid 2007 FIA Analysis Dataset falling within the geographic extent of the intensification that had been completed by 2013.

Forest	Analysis Dataset Name	# Plots	Years of data collection	Geographic area of inference	Brief Description
12, 15 – Helena, Lewis and Clark	F12 F15 Partial IntGrid 4X Hybrid 2013 (Inv. Dataset CN 2000005)	1772 plots 328 FIA 1444 IG	2006-2013 FIA: 1996-2007 IG: 2006-10, 2012-13	All of the Helena NF, subset of the Lewis and Clark, see Figure 3.	Analysis dataset for F12 and F15. Combination of F15 IntGrid 4X M1 2013 and F12 IntGrid 4x Hybrid 2013.
12 – Helena	F12 IntGrid 4x Hybrid 2012 (Inv. Dataset CN 1000023)	780 plots 145 FIA 635 IG	1996-2012 FIA: 1996-2007 IG: 2006-10, 2012	Entire Helena NF.	Analysis dataset for F12 IntGrid 4x Hybrid 2012. This includes the most recent available 4x intensified grid data and subplot 1 of the Hybrid FIA 2007 Analysis Dataset.
12 – Helena	F12 IntGrid 4x Hybrid 2013 (Inv. Dataset CN 2000004)	780 plots 145 FIA 635 IG	1996-2013 FIA: 1996-2007 IG 2006-10, 2012-13	Entire Helena NF.	Analysis dataset for F12 IntGrid 4x Hybrid 2013. This includes the most recent available 4x intensified grid data and subplot 1 of the Hybrid FIA 2007 Analysis Dataset.
12 – Helena	F12 IntGrid 4X M1 (Inv. Dataset CN 1000004)	781 plots 145 FIA 636 IG	1996-2009 FIA: 1996-1997 IG 2006 - 09	Entire Helena NF.	Helena Intensified Grid 4X intensification. Initial Inventory. Data set contains information from subplot 1 of FIA Periodic Analysis Dataset.
12 – Helena	F12 IntGrid 48X M1 (Inv. Dataset CN 1000005)	184 Plots 3 FIA 181 IG	1996-2008 FIA: 1996-1997 IG: 2006, 2008	Warm Springs and Elkhorns area.	Helena Intensified Grid 48X intensification. Initial Inventory. Data set contains information from subplot 1 of FIA Periodic Analysis Dataset falling within the geographic extent of the intensification.

Forest	Analysis Dataset Name	# Plots	Years of data collection	Geographic area of inference	Brief Description
12 – Helena	F12 BSLRP IntGrid 2013 (Inv. Dataset CN 2000009)	203 Plots 0 FIA 203 IG	IG: 2007-2010	Lincoln Ranger District	Dataset comprising of 203 Intensified Grid plots from the F12 IntGrid 4x Hybrid 2013 dataset within the Lincoln Ranger District. Used for Blackfoot Swan Landscape Restoration Project (BSLRP).

Table 5: Number of Intensified Grid plots by measurement year.

Analysis Dataset Name	Number of Intensified Grid Plots per Year							
	2006	2007	2008	2009	2010	2011	2012	2013
IntGrid Tally Lake 4X M1	144							
F12 IntGrid 4X Hybrid 2010	130	95	137	127	147			
F15 IntGrid Eastside 4X 2007				407	297			
F15 IntGrid 4X M1 2013				407	297		68	37
F12 F15 Partial IntGrid 4X Hybrid 2013	83	65	134	465	424		224	49
F12 IntGrid 4x Hybrid 2012	83	70	134	65	127		156	
F12 IntGrid 4x Hybrid 2013	83	65	134	58	127		156	12
F12 IntGrid 4X M1	201	229	205	1				
F12 IntGrid 48X M1	92		89					

Figure 1: Map showing Area of Inference for the Lewis and Clark Intensified Grid 4X Eastside Analysis Dataset.
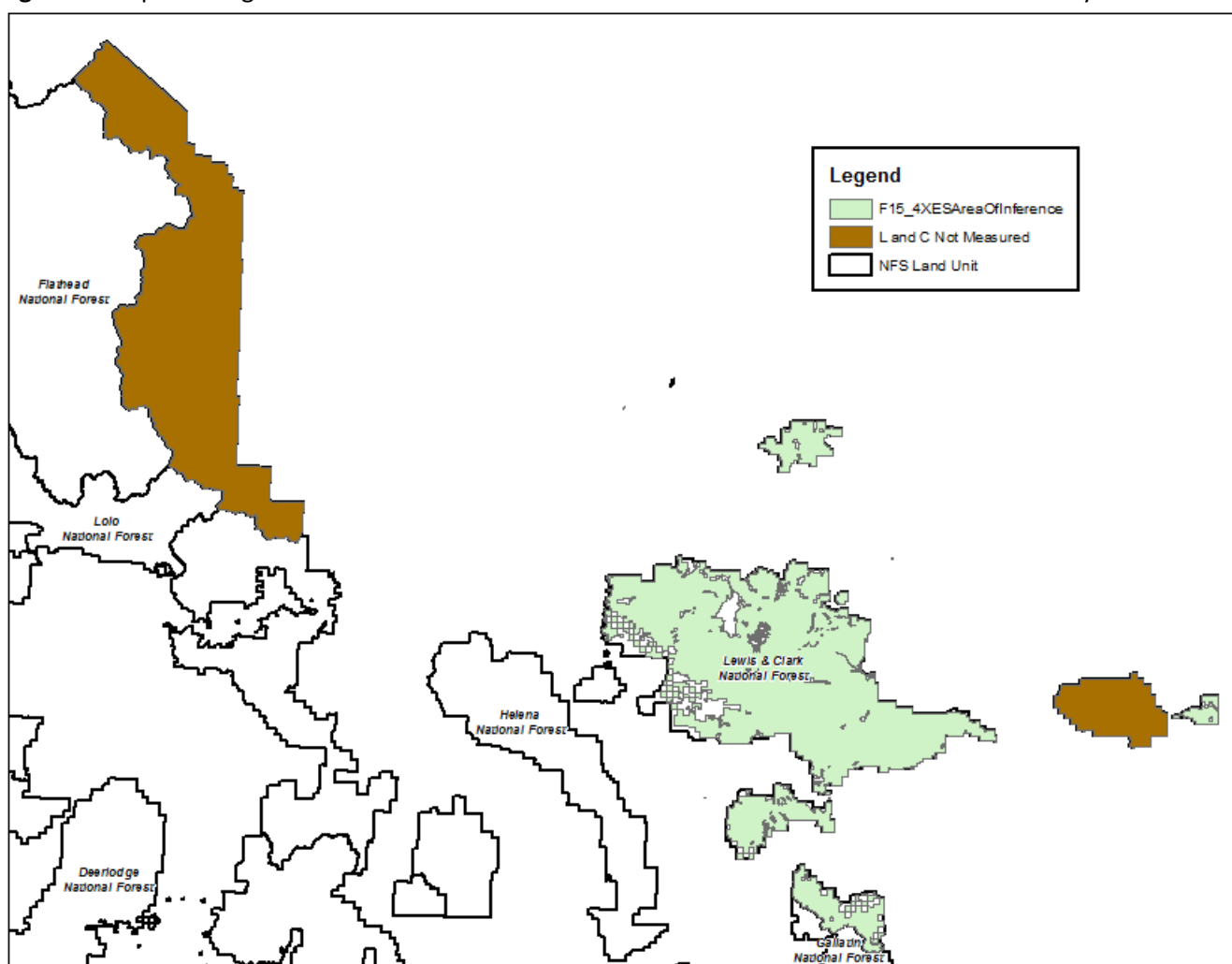
Figure 2: Map showing Area of Inference for the Lewis and Clark Intensified Grid 4X M1 2013 Analysis Dataset.
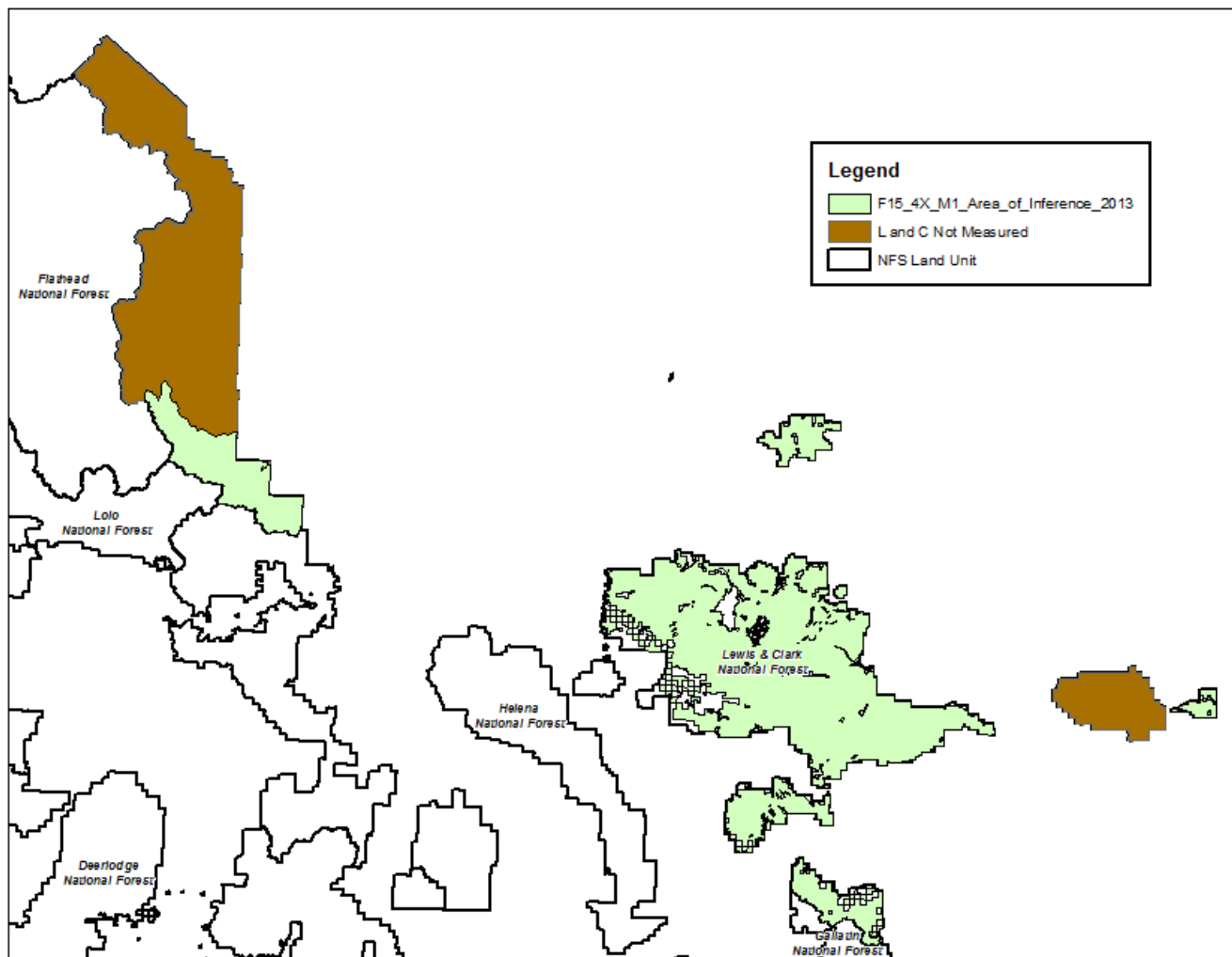
Figure 3: Map showing Area of Inference for the Helena/Lewis and Clark (Partial) Intensified Grid 4X 2013 Analysis Dataset.
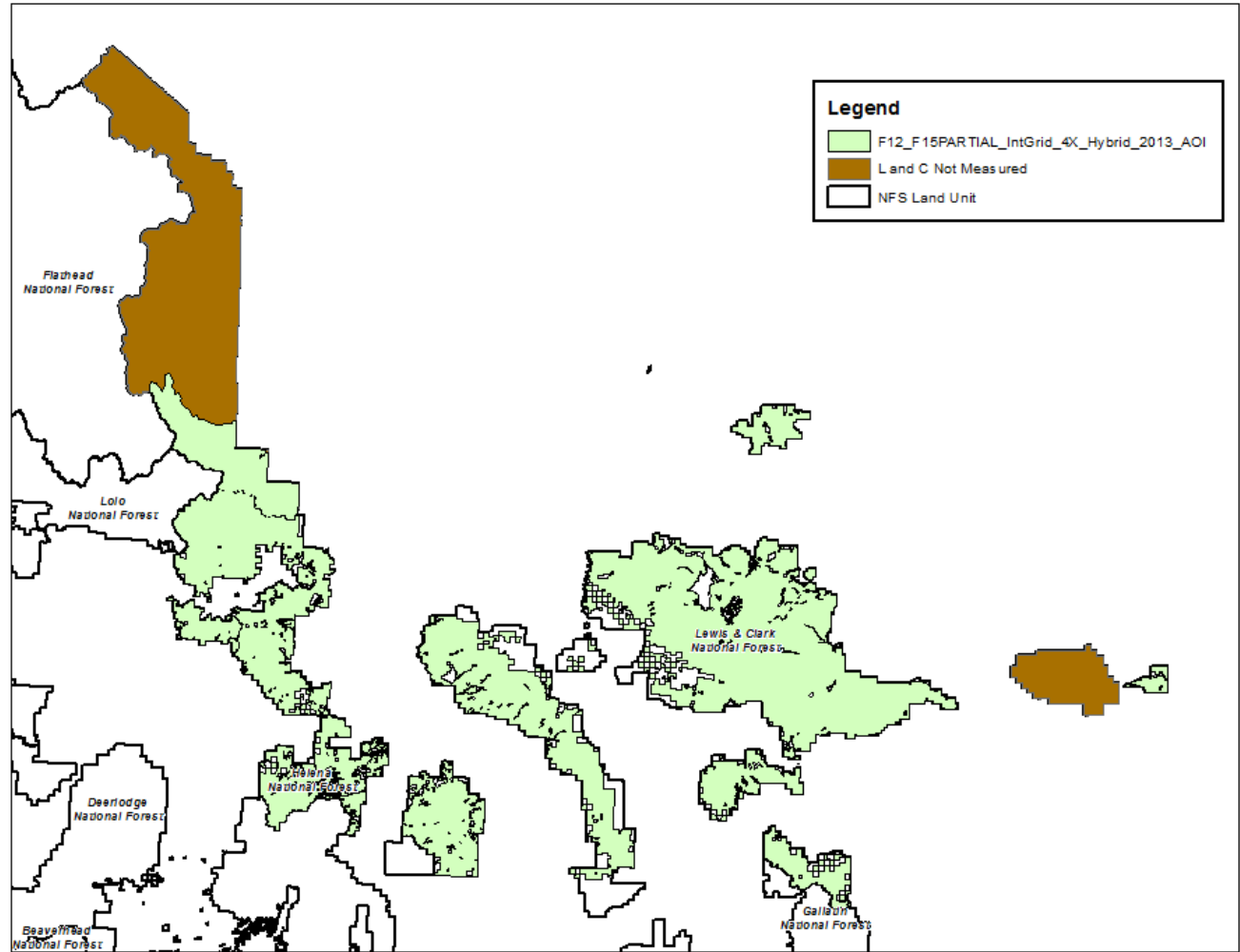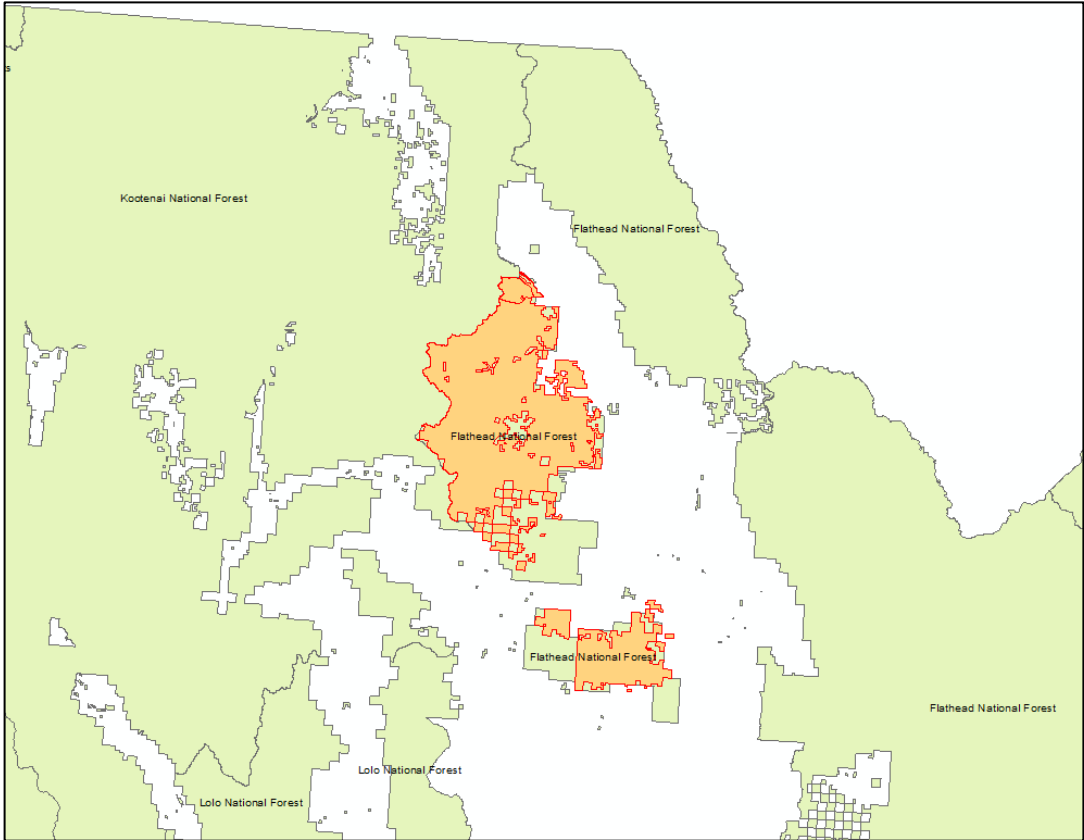
Figure 4. Map showing Area of Inference for the IntGrid Tally Lake 4X M1 Analysis Dataset.

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